

4/PCT

09/554617

527 Rec'd PCT/PTO 02 JUN 2000

1

## DESCRIPTION

### PRODUCTION METHOD OF DETERGENT AND PRODUCING APPARATUS

5

#### TECHNICAL FIELD

The present invention relates to a new washing process and a washing apparatus suitable to washing clothes, tableware, medical equipments and washing hands, etc.

10

#### BACKGROUND OF THE INVENTION

Surfactant, such as chemicals and soap, has been heretofore been used for washing clothes, tableware, medical equipment, toilets, etc., however, there have been problems of causing chapping hands when washing, a safety issue on body by residual detergent on washing items, and residual harmful substances after a treatment of discharging water, etc.

15

Inventors of the present invention proposed a method of washing washing items while softening washing water containing at least one of carbonate ion or bicarbonate ion and alkali metal ion (refer to PCT/JP99/00242, WO99/37414). This directs attention to the fact that a composite generated at the time of softening a solution containing alkali metal ion and

20

25

carbonate ion and/or bicarbonate ion realizes  
cleansing effect and adsorption effect, which shows  
detergency comparable to or more excellent than the  
conventional detergent such as surfactant and becomes  
5 human body-friendly and environment-friendly.

However, when trying to produce a solution  
containing alkali metal ion and carbonate ion and/or  
bicarbonate ion as an undiluted detergent it is  
necessary to use as its material a substance having a  
10 problem on handle ability such as sodium hydroxide,  
thus there has been a problem to carry out at home  
from producing detergent to washing.

#### DISCLOSURE OF INVENTION

15 The present invention has as an object thereof to  
provide a method of enabling to produce detergent only  
by substances superior in being handled and an  
apparatus therefor.

(1) According to a first aspect of the present  
20 invention, a method of producing detergent includes a  
step of electrolyzing a solution containing at least  
one of carbonate and bicarbonate of alkali metal.

Namely, as shown in Fig. 1, by making a solution  
of a substance containing at least one of carbonate  
25 and bicarbonate of alkali metal (see Step 1 to 2 in

Fig. 1) and by electrolyzing the solution (see Step 3 in Fig. 1), an undiluted detergent can be obtained (see Step 4 in Fig. 1).

By electrolyzing a solution containing at least one of carbonate and bicarbonate of alkali metal, for example, a solution of substances superior in handle ability such as sodium carbonate, potassium carbonate, lithium carbonate, potassium hydrogen carbonate, sodium hydrogen carbonate, as a solution to be electrolyzed, it is possible to obtain an undiluted detergent containing alkali metal ion and carbonate ion and/or bicarbonate ion, and by washing as softening the same, it shows detergency comparable to or better than the conventional detergent, such as surfactant, and becomes human body-friendly and environment-friendly. Accordingly, a series of procedures from producing detergency to washing can be realized at home.

As alkali metal carbonate according to the present invention, for example, sodium carbonate  $\text{Na}_2\text{CO}_3$ , potassium carbonate  $\text{K}_2\text{CO}_3$ , lithium carbonate  $\text{Li}_2\text{CO}_3$ , etc. can be listed, while as alkali metal bicarbonate, for example, potassium hydrogen carbonate  $\text{KHCO}_3$ , sodium hydrogen carbonate  $\text{NaHCO}_3$ , etc. can be listed.

Also, when making a solution of carbonate or bicarbonate of alkali metal, a variety of kinds of water may be used, such as tap water, well water, soft water, refined water, pure water, or mixed water of these, etc.

(2) Although, it is often the case that a pH, etc. of detergent to be used differ in accordance with a property of washing items, in the present invention, when producing detergent by electrolyzing a solution containing at least one of carbonate and bicarbonate of alkali metal, it is possible to adopt forms below in accordance with an aimed potential of hydrogen (pH=6 to 12) of the detergent.

As a first embodiment, cathode water or anode water obtained by electrolyzing by supplying the above solution to be electrolyzed at least to an anode chamber of an electrolyzing cell having a cathode chamber and an anode chamber separated by a diaphragm can be used as an undiluted detergent (see Fig. 4A). The cathode water obtained by this form becomes an alkaline undiluted detergent having a high pH.

In this case, as a second embodiment, when cathode water obtained by electrolyzing by supplying the above solution to be electrolyzed to both of the anode chamber and the cathode chamber of the

electrolyzing cell having a cathode chamber and an anode chamber separated by a diaphragm is used as an undiluted detergent, it is possible to obtain a highly concentrated undiluted detergent wherein rising of the pH is suppressed (see Fig. 4B).

Also, as a third embodiment, cathode water or anode water obtained by electrolyzing by supplying the above solution to be electrolyzed at least to an anode chamber of an electrolyzing cell having a cathode chamber and an anode chamber separated by a diaphragm or mixture of the both water is further added and dissolved at least one of carbonate and bicarbonate of alkali metal after completing the electrolysis and thus obtained solution can be used as an undiluted detergent (see Fig. 4C).

Furthermore, as a fourth embodiment, by electrolyzing by supplying the above solution to be electrolyzed at least to an anode chamber of an electrolyzing cell having a cathode chamber and an anode chamber separated by a diaphragm, and mixing the obtained cathode water or anode water after the electrolysis is completed, the thus obtained solution can be used as an undiluted detergent (see Fig. 4D).

In this case, as a fifth embodiment, it is also possible to use as an undiluted detergent mixture of

cathode water or anode water obtained by electrolyzing by supplying the solution to be electrolyzed to both of the anode chamber and the cathode chamber of the electrolyzing cell having a cathode chamber and an anode chamber separated by a diaphragm (see Fig. 4E).

In the fourth and fifth embodiments, since the mixture of the anode water and the cathode water becomes an undiluted detergent, a production amount of the obtained undiluted detergent becomes doubled, or otherwise, the capacity of the electrolysis cell can be halved.

The cathode water in the first embodiment, the cathode water in the second embodiment, the cathode water in the third embodiment, the mixed water in the fourth embodiment and the mixed water in the fifth embodiment have a pH of 9.5 to 12.0 and can be used as an alkaline undiluted detergent.

On the other hand, the anode water in the first embodiment and the anode water in the third embodiment have a pH of 6 to 8 and can be used as a neutral undiluted detergent.

In a method of producing detergent of the present invention, the pH and electric conductivity can be easily adjusted by suitably setting the conditions of electrolysis.

(3) The above undiluted detergent can be used for washing as it is or diluted (see Step 5 to 6 in Fig. 1. Hereinafter, also referred to as a diluted detergent A). An electric conductivity of the diluted detergent is 100mS/m or more, preferably, 150mS/m or more.

Also, a variety of washing aid agents for improving detergency, etc. can be added (see Step 9 in Fig. 1).

10 Namely, the above alkaline detergent can be added fatty acid or soap, such as oleic acid or oleic acid potassium, at the time of or after being diluted by water, to be used as detergent.

Also, the above neutral detergent can be added a  
15 variety of washing aid agents to be used as detergent, such as antisoil redeposition (for example, carboxyl methyl cellulose), nonionic surfactant (for example, sugar fatty acid ester, polyoxyethylene sorbitan fatty acid ester), dispersing agents (for example, carboxyl  
20 methyl cellulose) and water softening agents (for example, EDTA, citric acid).

Auxiliary/aid agents used in the present invention are emulsifier (surfactant) used for food processing and gum/thickening agent as food additives, and by not using the conventional surfactant for  
25

washing, safer detergent can be provided. Furthermore, since the detergency is given to the electrolytic water obtained by electrolysis of a solution of alkali metal carbonate/bicarbonate, the surfactant can be  
5 made to be minimum thickness required for antisoil redeposition, and it becomes possible to reduce a burden on an environment by suppressing usage of organic substances.

(4) Note that the present invention may include  
10 a step of softening the detergent containing at least one of carbonate ion and bicarbonate ion and alkali metal ion, particularly the above undiluted detergent or the diluted detergent A (see Steps 7 to 8. Hereinafter, the obtained detergent will be also  
15 referred to as diluted detergent B).

In this case, it is preferable to adopt a means to make it contact solid carbonate composite which is water-insoluble or hard to be dissolved in water.

(5) Further, according to a second aspect of  
20 the present invention, an electrolysis cell wherein an anode chamber and a cathode chamber are separated by a diaphragm, a solution tank for making a solution by dissolving at least carbonate or bicarbonate of alkali metal in water, a detergent producing apparatus having  
25 a first supply means for supplying the solution in the



solution tank at least to the anode chamber of the electrolysis cell and a mixing means for mixing anode water and cathode water respectively generated in the anode chamber and the cathode chamber to make mixed electrolytic water after completion of the electrolysis are provided.

In this case, preferably, the mixing means comprises a water tank for storing anode water and cathode water after completion of the electrolysis and a second supply means for supplying the anode water and cathode water generated in said anode chamber and cathode chamber to said water tank.

Also, there is provided a detergent producing apparatus, comprising an electrolysis cell wherein an anode chamber and a cathode chamber separated by a diaphragm, a solution tank for making a solution by dissolving at least one of carbonate and bicarbonate of alkali metal in water, a first supply means for supplying the solution in said solution tank at least to the anode chamber of said electrolysis cell, a detergent tank for storing detergent discharged from said electrolysis cell, and a third supply means for supplying one of cathode water after completing the electrolysis generated in said cathode chamber and anode water after completing the electrolysis

generated in said anode chamber to said detergent tank.

In this case, it is preferable to comprise a means for adding and dissolving at least one of  
5 carbonate and bicarbonate of alkali metal to at least one of anode water generated in said anode chamber and cathode water generated in said cathode chamber.

(6) According to a third aspect of the present invention, there is provided a washing machine  
10 comprising a detergent producing apparatus for producing detergent by electrolyzing a solution containing at least one of carbonate and bicarbonate of alkali metal; a detergent tank for storing said detergent; a washing tub for washing; a means for  
15 supplying diluting water of said detergent to said washing tub; and a means for supplying said detergent from said detergent tank to said washing tub.

In this case, it is preferable to further comprises a judgement means for judging an amount of  
20 washing items and/or an amount of washing water in said washing tub and a setting means for setting the amount of washing items and the amount of washing water; and a control means for outputting to said detergent supply means a control signal for supplying  
25 the washing tub an appropriate amount of detergent for

washing based on an output signal from said judgement means or said setting means.

Furthermore, it is preferable to comprise a container for storing washing aid agents, a means for supplying washing aid agents from said container to said washing tub, and a control means for outputting to said supply means of washing aid agent a control signal for supplying an appropriate amount of the washing aid agents for washing to the washing tub.

(7) The above detergent producing apparatus or washing apparatus can be applied to a washing machine, dish washer, etc.

#### BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is a view of processes of an embodiment of a method of producing detergent of the present invention.

Fig. 2 is a view of a pH range of detergent obtained by a method of producing detergent of the present invention.

Fig. 3 is a schematic view of an embodiment of a washing apparatus of the present invention.

Figs. 4A to 4E are views of respective use forms of an electrolysis cell of Fig. 3.

#### BEST MODE FOR CARRYING OUT THE INVENTION

First, an embodiment of applying a detergent producing apparatus of the present invention to a washing machine will be explained. Figure 3 is a schematic view of an example of a washing machine WM wherein a detergent producing apparatus of the present invention is applied, and details of an electrolysis cell 11 shown in the same figure will be explained with reference to Figs. 4A to 4E.

The detergent producing apparatus 1 of the present embodiment comprises a solution tank 12 for storing alkali metal sodium solution containing at least one of alkali metal carbonate and alkali metal bicarbonate (hereinafter, also referred to as a solution to be electrolyzed), an electrolysis cell 11 and a first supply system 13 for supplying the solution to be electrolyzed from the solution tank 12 to the electrolysis cell 11.

The solution tank 12 is supplied a substance containing at least one of alkali metal carbonate and alkali metal bicarbonate (sodium hydrogen carbonate in this example) from a container 16 storing the same and tap water, etc. from a tap water source, etc. via a supply system 17. An example below is for explaining a case of using sodium hydrogen carbonate.

As shown in Figs. 4A to 4E, the electrolysis

cell 11 is formed an inlet 111 for being introduced a solution to be electrolyzed and an outlet 112 for taking out generated electrolytic water, and an electrolysis chamber 113 is formed between the inlet  
5 111 and the outlet 112.

Also, at the approximate center of the electrolysis chamber 113 is provided with a diaphragm 114 formed by a cation exchange film, and both electrolysis chambers 113a and 113c over the diaphragm  
10 114 are respectively provided with a pair of electrode plates 115a and 115c facing to each other. Here, while not illustrated, the pair of electrode plates 115a and 115c are connected to a direct current power source, and one electrode plate 115a is to be applied the  
15 anode while the other electrode plate 115c is to be applied the cathode. Below, the electrolysis chamber 113a will be also referred to as an anode chamber, the electrolysis chamber 113c a cathode chamber, electrolytic water generated in the anode chamber an  
20 anode water, and electrolytic water generated in the cathode chamber a cathode water.

As the diaphragm 114, a variety of ion exchange films, nonionic selective films, multi-porous films may be used. These films are provided for preventing  
25 anode water generated around the anode and cathode

water generated around the cathode from being mixed.  
In the case of using a cation exchange film as in the  
present example, less hydroxide ion generated in the  
cathode chamber 113c transmits to the anode chamber  
5 113a, so that it is preferable because it becomes easy  
to refrain the pH of the obtained undiluted detergent  
of anode water from becoming alkaline, and to heighten  
the pH of the cathode water to be obtained to produce  
a strong alkaline undiluted detergent of cathode  
10 water.

As the electrode plates 115a and 115c, it is  
preferable to be configured by materials not melted by  
electricity. Specifically, for example, platinum  
family metals, titanium, etc. have excellent corrosion  
15 resistance and preferably used. The distance between  
the electrode plates 115a and 115c is 1mm to 6mm, more  
preferably, 5mm.

Further, to explain use forms the electrolysis  
cell 11 shown in Figs. 4A to 4E, in Fig. 4A, the anode  
20 chamber 113a is supplied a solution of sodium hydrogen  
carbonate from the solution tank 12, while the cathode  
chamber 113c is supplied tap water, etc. Both of anode  
water generated in the anode chamber 113a and cathode  
water generated in the cathode chamber 113c may be  
25 used as undiluted detergent. According to this use

form, little hydroxide ion generated in the cathode chamber 113c transmits to the anode chamber 113a, so it is possible to refrain the pH of the undiluted detergent of anode water from becoming alkaline, and it becomes easy to heighten the pH of cathode water to be obtained and to produce a strong alkaline undiluted detergent of cathode water.

On the other hand, in the use form shown in Fig. 4B, although sodium hydrogen carbonate solution is supplied to both the anode chamber 113a and the cathode chamber 113c from the solution tank 12, only cathode water generated in the cathode chamber 113c is used as undiluted detergent. In this case, since a sodium hydrogen carbonate solution is supplied to the cathode chamber 113c, the undiluted detergent of cathode water to be obtained is suppressed not to rise the pH, so that weak alkaline undiluted detergent can be obtained and highly concentrated undiluted detergent can be generated.

Also, the use form shown in Fig. 4C is a modified example of the one shown in Fig. 4A, and the anode chamber 113a is supplied sodium hydrogen carbonate solution from the solution tank 12 while the cathode chamber 113c is supplied tap water, etc., and obtained anode water and cathode water are respectively further

added with at least one of sodium carbonate and sodium hydrogen carbonate to become an undiluted detergent. According to this use form, it is possible to adjust the pH and concentration of the anode water and cathode water respectively obtained in the anode chamber 113a and the cathode chamber 113c after the electrolysis.

Furthermore, the use form shown in fig. 4D is also a modified example of the one shown in Fig. 4A, wherein also the anode chamber 113a is supplied sodium hydrogen carbonate solution from the solution tank 12 while the cathode chamber 113c is supplied tap water, etc., but the obtained anode water and the cathode water are mixed to be an undiluted detergent. According to this use form, since all of the anode water and the cathode water are used, the production amount of the undiluted detergent to be obtained is doubled, or otherwise, the capacity of the electrolysis cell 11 may be halved.

Also, the use form shown in Fig. 4E is a modified example of the one shown in Fig. 4D, wherein both of the anode chamber 113a and the cathode chamber 113c are supplied sodium hydrogen carbonate solution from the solution tank 12, and the obtained anode water and the cathode water are mixed to be an undiluted



detergent. According to this use form, all of the anode water and the cathode water are used, so the production amount of the undiluted detergent to be obtained is doubled, or the capacity of the electrolysis cell 11 may be halved.

As explained above, according to the electrolysis 11 of the present invention, a variety of aimed undiluted detergent can be obtained by suitably changing the use form. The states are schematically shown in Fig. 2.

Returning to Fig. 3, the first supply system 13 is provided with a pipe 131 for connecting a solution tank 12 to the inlet 111 of the electrolysis cell 11 and a pump 132 for sending by pressure the solution to be electrolyzed in the solution tank 12 to the electrolysis cell 11.

Furthermore, the detergent producing apparatus 1 of the present embodiment comprises a detergent tank 15 for storing electrolytic water generated in the anode chamber 113a and/or the cathode chamber 113c of the electrolysis cell 11, a second supply system 14 for supplying the electrolytic solution from the electrolysis cell 11 to the detergent tank 15, and a diluting means 18 for diluting the undiluted detergent generated in the electrolysis cell 11.

The second supply system 14 is comprised by a pipe 141 for connecting the outlet 112 of the electrolysis cell 11 to the detergent tank 15 and a pump 142 provided on the pipe 141 for sending by pressure the electrolytic solution generated in the electrolysis cell 11 to the detergent tank 15.

Note that in the use form shown in Fig. 4C, when adding sodium hydrogen carbonate to the anode water or cathode water generated in the electrolysis cell 11 later on, it is sufficient to supply it from the container 16 shown in Fig. 3.

Also, the diluting means 18 is comprised by a supply pipe 181 for supplying diluting water from a not shown tap water source to the detergent tank 15 and a pump 182 by which the undiluted detergent is diluted by a predetermined diluting rate to become diluted detergent A.

The above detergent producing apparatus 1 is provided to a washing machine body 2 having a washing tub 21. It further comprises a third supply system 22 for supplying electrolytic water (diluted detergent A) stored in the detergent tank 15 to the washing tub 21 via a water softening filter 23. The third supply system 22 is comprised by a pipe 221 for connecting the detergent tank 15 to the water softening filter 23

and a pump 222 provided on the pipe 221 for sending by pressure the diluted detergent A stored in the detergent tank 15 to the water softening filter 23.

5 The water softening filter 23 is provided in this example for softening the undiluted detergent (see Step 4 in Fig. 1) as it is obtained by the detergent producing apparatus 1 or diluted detergent A after diluting (see Step 6 in Fig. 1).

10 In the water softening filter 23, inside its casing is filled with solid hydroxide composite which is insoluble or hard to be dissolved in water, for example, calcium carbonate or calcium phosphate, and by making the above undiluted detergent and diluted detergent contact such carbonate composites, calcium  
15 ion and magnesium ion included in the undiluted detergent and diluted detergent are reduced as calcium carbonate and magnesium carbonate, and thereby, the detergent can be made to be low in hardness. Note that the carbonate composite may be in a suitably  
20 granulated ball shape or pelletized form other than powder and a crushed shape, and may include filling agents and amount increasing agents other than carbonate composite. Also, the solid carbonate composite is sufficient if at least the surfaces  
25 thereof are carbonate composite, and may be a compound

body wherein a suitable core body is covered with carbonate composite.

Returning back to Fig. 3, the washing tub 21 is provided with a fourth supply system 24 for supplying  
5 tap water, etc. for diluting the detergent, and the fourth supply system 24 is configured by a pipe 241, a pump 242 and a not shown tap water supplying source.

Furthermore, the washing machine WM of the present embodiment is provided with a washing aid  
10 agent tank 25 for storing a variety of washing aid agents, such as antisoil redeposition (for example, carboxyl methyl cellulose), nonionic surfactant (for example, sugar fatty acid ester, polyoxyethylene sorbitan fatty acid ester), dispersing agents (for  
15 example, carboxyl methyl cellulose) and water softening agents (for example, EDTA, citric acid), and a fifth supply system 26 for supplying the washing aid agents stored in the washing aid agent tank 25 to the washing tub 21. The fifth supplying system 26 is  
20 configured by a pipe 261 and a pump 262.

Furthermore, the washing machine WM of the present embodiment is provided as a control system with a judgement/setting means 27 for detecting and  
judging or manually setting an amount of washing items  
25 put in the washing tub 21 or an amount of washing

water filled in the washing tub 21 and a control means 28 for controlling the operations of the pumps 222 and 262 based on the amounts of washing items or washing water input to the means 27. As a result, detergent and washing aid agents in accordance with the washing load are supplied respectively from the detergent tank 15 and the washing aid agent tank 25 to the washing tub 21.

Next, an example of washing process using the above washing machine WM will be explained.

First, an anode of a direct current power source of the detergent producing apparatus 1 is connected to the electrode plate 115a, while a cathode is connected to the electrode plate 115c, and a direct current voltage is applied to the both electrode plates 115a and 115c. Then, the pump 132 is operated to introduce sodium hydrogen carbonate solution as the solution to be electrolyzed from the solution tank 12 to the inlet 111. As a result, electrolysis is carried out in both of the electrolysis chambers 113a and 131c, and after a certain period of time, electrolytic solution is discharged from the respective outlets 112. These electrolytic waters are supplied to the detergent tank 15 by the pump 142 via the pipe 141, mixed during the time and becomes an undiluted detergent of the present

invention.

The undiluted detergent stored in the detergent tank 15 is diluted by the diluting means 18, and then supplied to the water softening filter 23, wherein it is softened, and supplied to the washing tub 21 of the washing machine WM.

At this time, amounts of detergent and washing aid agents to be supplied are controlled in accordance with the amount of washing items. Namely, when the judging means automatically detects or setting means 27 is manually input the amount of washing items (for example, the weight, volume, etc.) put in the washing tub 21 and the amount of tap water poured in the washing tub 21, a signal is sent to the control means 28 and a signal of operation time, etc. in accordance with the washing load is sent therefrom to the pumps 222 and 262. As a result, the washing tub 21 is supplied an appropriate amount of detergent and washing aid agents in accordance with the washing load.

A specific example of producing detergent by the present invention will be explained next.

Embodiment 1 (Fig. 4A)

A saturated solution of sodium hydrogen carbonate prepared by dissolving and diluting 100g of sodium

hydrogen carbonate in 1 litter of tap water (municipal tap water in Fujisawa city, pH 7.2, EC 15.5mS/m, water temperature 24.5°C) was supplied to the anode chamber 113a of the batch type electrolysis cell 11 (a capacity of the anode chamber and the cathode chamber are both 0.5 litter) shown in Fig. 4A, and the above tap water was supplied to the cathode chamber 113c shown in the same figure. Then, electrolysis was carried out by applying a direct current voltage so that a constant current of 20A flows to both the electrode plates 115a and 115c, and pH and electric conductivity EC of an undiluted solution of cathode water obtained at every five minutes and a diluted solution by diluting the same to be thirty times (30 litters) were measured. Measurement of the diluted water was made after mixing for one minute. The result will be shown in Table 1.

Note that a pH was measured by using a pH meter (trade name of D-13, manufactured by Horiba Ltd.), an EC was measured by using an EC meter (trade name of CM-14P, manufactured by TOA Corporation). The mark \* of EC in the table indicates it exceeded the measurable limit (1999mS/m or less).

Both of the undiluted detergent and diluted detergent A obtained in the present embodiment become

alkaline having a pH of 10.5 or more, and those which  
had a long electrolysis time became detergent having  
strong alkaline and the EC value of 100mS/m or more,  
so that it becomes preferable to be used as detergent  
5 for non fibrous washing items, such as tableware.



Table 1

	undiluted electrolytic solution		diluting water	
	pH	EC (mS/m)	pH	EC (mS/m)
before electrolysis	7.23	15.5	-	-
after 3 min.	12.64	2000 or more *	10.53	47.1
after 5 min.	12.88	2000 or more *	10.92	59.6
after 10 min.	13.05	2000 or more *	11.34	87.2
after 15 min.	13.20	2000 or more *	11.79	133.0
after 20 min.	13.35	2000 or more *	12.26	180.3

Embodiment 2 (Fig. 4B)

A solution prepared by dissolving and diluting 36g of sodium hydrogen carbonate in 1 liter of tap

water (municipal tap water in Fujisawa city, pH 7.3, EC 17.9mS/m, water temperature 20.2°C) was supplied to the cathode chamber 113c of the batch type electrolysis cell 11 (a capacity of the anode chamber and the cathode chamber are both 1 litter) shown in Fig. 4B, and saturated solution of sodium hydrogen carbonate was supplied to the anode chamber 113a. Then, electrolysis was carried out by applying a direct current voltage so that a constant current of 15A flows to both of the electrode plates 115a and 115c, and a pH and electric conductivity EC of an undiluted solution of cathode water obtained at every ten minutes and a diluted solution by diluting the same to be thirty times (30 litters) were measured. Measurement of the diluted water was made after mixing for one minute. The result will be shown in Table 2.

Both of the undiluted detergent and diluted detergent A obtained in the present embodiment become weak alkaline of a pH of 9.0 to 10.5, and the EC value of 100mS/m or more, so that it becomes preferable to be used as detergent for fibrous washing items, such as cotton, hemp, rayon, polynosic, polyester, nylon and acryl.

Table 2

	undiluted electrolytic water		diluting water	
	pH	EC (mS/m)	pH	EC (mS/m)
before electrolysis	8.02	2000 or more *	8.20	120.3
after 10 min.	9.36	2000 or more *	9.52	140.3
after 20 min.	9.65	2000 or more *	9.94	168.0
after 30 min.	9.98	2000 or more *	10.23	196.9
after 36 min.	10.20	2000 or more *	10.44	204.0

### Embodiment 3 (Fig. 4E)

A solution prepared by dissolving and diluting 36g of sodium hydrogen carbonate in 2 liters of tap water (municipal tap water in Fujisawa city, pH 7.3, EC 18.5mS/m, water temperature 20.6°C) was divided to be 1 liter and respectively supplied to the anode

chamber 113a and the cathode chamber 113c of the batch type electrolysis cell 11 (a capacity of the anode chamber and the cathode chamber are both 1 liter) shown in Fig. 4E. Then, electrolysis was carried out by applying a direct current voltage so that a constant current of 15A flows to both the electrode plates 115a and 115c, and a pH and electric conductivity EC of mixture of an undiluted solution of anode water and cathode water obtained at every ten minutes and a diluted solution by diluting the same to be thirty times (30 liters) were measured. Measurement of the diluted water was made after mixing for one minute. The result will be shown in Table 3.

Both of the undiluted detergent and diluted detergent A obtained in the present embodiment became weak alkaline of a pH of 8.5 to 10.5, and the EC value of 100mS/m or more, so that it becomes preferable to be used as detergent for fibrous washing items, such as cotton, hemp, rayon, polynosic, polyester, nylon and acryl.

Table 3

	undiluted electrolytic solution		diluting water	
	pH	EC (ms/m)	pH	EC (ms/m)
before electrolysis	8.06	1460	8.13	121.3
after 5 min.	8.72	1455	8.84	119.3
after 15 min.	9.56	1492	9.68	120.9
after 25 min.	10.21	1531	10.25	126.7

Embodiment 4 (Fig. 4E)

A solution prepared by dissolving and diluting 72g of sodium hydrogen carbonate in 1 liter of tap water (municipal tap water in Fujisawa city, pH 7.2, EC 15.5mS/m, water temperature 24.5°C) was divided to be 0.5 liter and respectively supplied to the anode chamber 113a and the cathode chamber 113c of the batch

type electrolysis cell 11 (a capacity of the anode chamber and the cathode chamber are both 1 litter) shown in Fig. 4. Then, electrolysis was carried out by applying a direct current voltage so that a constant current of 20A flows to both the electrode plates 115a and 115c, and a pH and electric conductivity EC of an undiluted solution of anode water obtained at every ten minutes and a diluted solution by diluting the same to be thirty times (30 litters) were measured. Measurement of the diluted water was made after mixing for one minute. The result will be shown in Table 4.

Both of the undiluted detergent and diluted detergent A obtained in the present embodiment became neutral of a pH of 7.0 to 8.0, and the EC value of 100mS/m or more, so that it becomes preferable to be used as detergent for fibrous washing items, such as silk, wool, cupra, acetate.

Table 4

	undiluted electrolytic solution		diluting water	
	pH	EC (ms/m)	pH	EC (ms/m)
before electrolysis	8.02	-	-	-
after 20 min.	7.70	2000 or more *	7.82	164.5
after 30 min.	7.70	2000 or more *	7.85	133.6

Next, an embodiment of comparing detergency on a various kinds of stains will be explained by using the detergent produced by using the method of producing detergent of the present invention and commercially available detergent.

Embodiment 5 (weak alkaline detergent)

In the same way as in the Embodiment 3, a solution prepared by dissolving and diluting 22.5 of sodium hydrogen carbonate in 0.5 liter of tap water (municipal tap water in Fujisawa city, pH 7.2, EC 15.5mS/m, water temperature 24.5°C) was supplied to the

anode chamber 113a and the cathode chamber 113c of the batch type electrolysis cell 11 (a capacity of the anode chamber and the cathode chamber are both 0.5 liter) shown in Fig. 4E. Then, electrolysis was carried out by applying a direct current voltage so that a constant current of 20A flows to both the electrode plates 115a and 115c for 17 minutes. Thus obtained anode water and cathode water were mixed and 1 liter of mixed water was obtained.

A washing tub of a domestic washing machine of double-tub type (trade name of ES-25E, 2.5kg type, manufactured by Sharp Corp.) was filled with 30 liters of tap water and put in 1000cc of the above mixed water detergent (diluting rate = 30 times). The diluted detergent had a pH of 10.2, EC value of 164.5mS/m, and a water temperature of 25°C.

A standard stained fabric with "dirt on a collar", and "mixed stain of china ink and olive oil", "blood", "cacao butter (animal and vegetable oil)", "red wine", and "mixed stain of blood, milk and china ink" being allowed to adhere to cotton fabric samples, respectively (EMPA101, 111, 112, 114, 115 and 116), were washed with the washing machine for 12 minutes, spin-dried and dried by a drier.

The detergency ratio of the respective stained



fabrics before and after washing is shown in Table 5. Note that the "detergency ratio" was calculated by the formula below.

5           Detergency ratio % = (whiteness index of stained fabric after washing - whiteness index of stained fabric before washing) ÷ (whiteness index of unstained fabric - whiteness index of stained fabric before washing) × 100

10           Here, the "whiteness index" is an average of ten points on two sides of the artificially stained fabric measured by a whiteness index measure (trade name of CR-14, Whiteness Index Color Reader, manufactured by  
15 Minolta Co., Ltd.).

Comparative Example 1

20           As an comparative example of the embodiment 5, the same stained fabrics as in the Embodiment 5 were washed by using a commercially available synthetic detergent for washing (Attack (registered trademark), Kao Corporation) and a whiteness index and the detergency ratio were calculated. The results are shown in Table 5.

Table 5

kind of stained fabric		detergency ratio	
stained fabric	stain	embodiment 5	comparative example 1
standard stained fabric	dirt on collar	49.7	44.5
EMPA101	china ink and olive oil	11.2	8.3
EMPA111	blood	81.1	44.7
EMPA112	cacao	19.6	11.7
EMPA114	red wine	13.8	19.9
EMPA116	mixed stain of blood, milk and china ink	15.2	13.6

From the result, it was confirmed that the weak alkaline detergent (mixed electrolytic water) obtained by the present invention had detergency comparable to

or better than the commercially available synthetic detergent. Especially, it is remarkably improved as to blood stain. Note that the detergent of the fifth embodiment had no problems at all concerning safety and treatment of discharging water after washing.

Embodiment 6 (neutral detergent)

A solution prepared by dissolving and diluting 36g of sodium hydrogen carbonate in 1 liter of tap water (municipal tap water in Fujisawa city, pH 7.2, EC 15.5mS/m, water temperature 24.5°C) was supplied to the anode chamber 113a and the cathode chamber 113c of the batch type electrolysis cell 11 (a capacity of the anode chamber and the cathode chamber are both 1 liter) shown in Fig. 4C, and electrolysis was carried out by applying a direct current voltage so that a constant current of 15A flows to both the electrode plates 115a and 115c for 36 minutes. When measuring a pH and EC value of thus obtained anode water, pH=7.06 and EC=971mS/m.

The anode water was further added with 52g of sodium hydrogen carbonate and additionally added with 3g of cane sugar fatty acid ester and 2g of carboxyl methyl cellulose.

A washing tub of a domestic automatic washing machine (trade name of AW-C60VP, 6kg type,

manufactured by Toshiba Corporation) was filled with 31 liters of tap water and put in 1000cc of the above detergent (diluting rate = 31 times). The diluted detergent had a pH of 8.0, EC value of 175.5mS/m, and a water temperature of 20.1°C.

A standard stained fabric with "dirt on collar", and "mixed stain of china ink and olive oil", "blood", "cacao butter (animal and vegetable oil)", "red wine", and "mixed stain of blood, milk and china ink" being allowed to adhere to cotton fabric samples, respectively (EMPA101, 111, 112, 114, 115 and 116), were washed by setting the water current switch to pressing washing course for 3 minutes (soaked for 5 minutes before washing), rinsed for two times, spin-dried for 4 minutes and dried by a drier.

The detergency ratio of the respective stained fabrics before and after washing is shown in Table 6. note that the "detergency ratio" and "whiteness" were measured and calculated in the same way as in the fifth embodiment.

#### Comparative Example 2

As a comparative example of Embodiment 6, the same stained fabric as in the Embodiment 6 was washed by using a commercially available neutral detergent for washing (Acron, Lion Corporation) and the

detergency ratio was calculated. The results are shown in Table 6.

Table 6

kind of stained fabric		detergency ratio	
stained fabric	stain	embodiment 6	comparative example 2
standard stained fabric	dirt on collar	13.8	12.5
EMPA101	china ink and olive oil	5.3	4.5
EMPA111	blood	52.5	34.9
EMPA112	cacao	3.9	6.0
EMPA114	red wine	24.3	19.7
EMPA116	mixed stain of blood, milk and china ink	10.2	8.3

From the result, it was confirmed that the neutral detergent obtained by the present invention had detergency comparable to or better than the commercially available neutral detergent. Especially,

it is remarkably improved as to blood stain. Note that the detergent of the sixth embodiment had no problems at all concerning safety and treatment of discharging water after washing.